

# Plasma Sheet Access to Geosynchronous Orbit

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# Topics

- Database and data analysis technique.
- Drift trajectories and  $(U, B, K)$  coordinates.
- Kp parametrization of electric field models.
- Results.
- Summary.



## The Database

- Three Los Alamos geosynchronous satellites: 1990-095, 1991-080, and 1994-084.
- Magnetospheric Plasma Analyzer (MPA).
- Energy range:  $1 \text{ eV} \lesssim E_{p,e} \lesssim 40 \text{ keV}$ .
- Spin-averaged fluxes and moments.
- Dates included: 01/01/1996 – 12/31/1996.
- Number of 10-sec. measurements:  $\sim 1$  million.

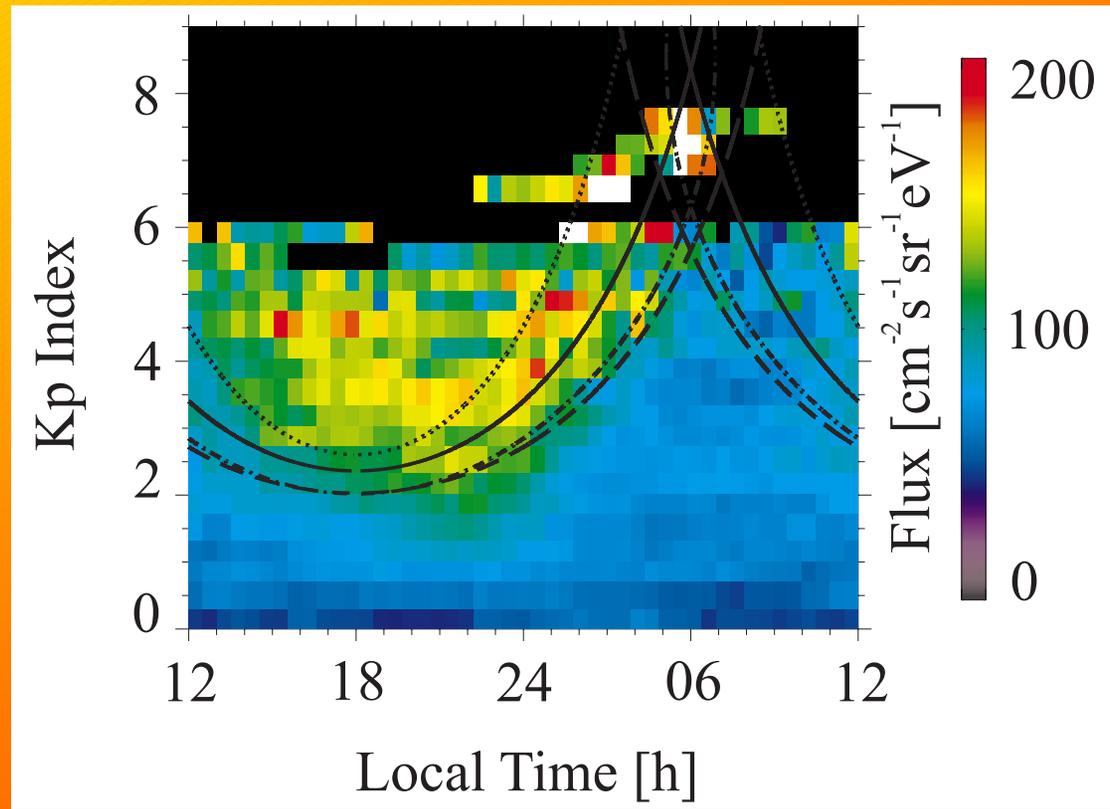


## Data Analysis Technique

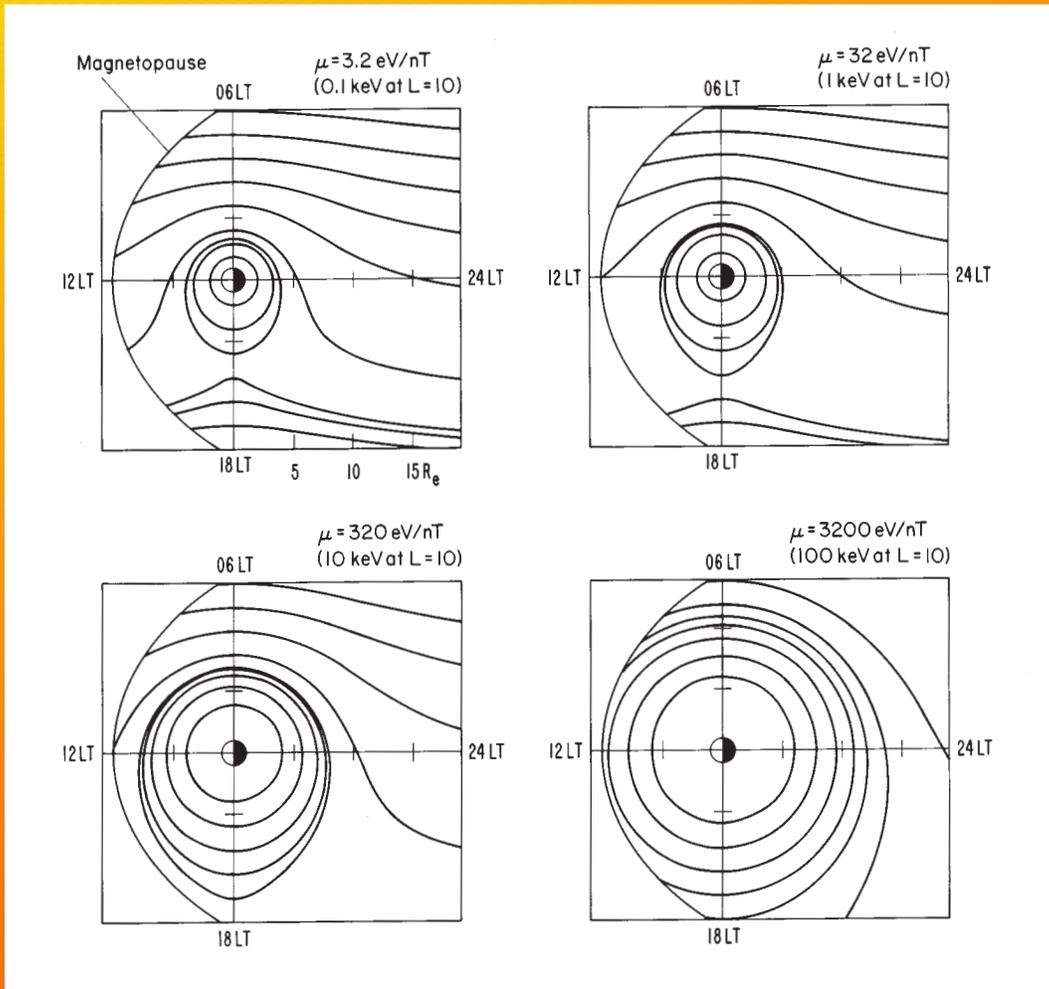
- Procedure:
  1. Median calculation for 0.5 hour interval of LT.
  2. Sorting of median values into bins according to LT and Kp.
  3. Average the median values in each LT-Kp bin.
- Magnetosheath and boundary layer intervals are excluded.



## Differential Flux of 31.0 keV Protons



# Electron Drift Trajectories



from Lyons and Williams,  
Quantitative Aspects of Magnetospheric Physics, 1984.



## The (U,B,K) Theory

- Introduced by Whipple, *JGR*, 83, 4318–4326, 1978, also Sheldon, e.g. *GRL*, 20, 767–770, 1993.
- Total Energy:  $W_{\text{tot}} = qU + \mu B_m$ ,

$$\Rightarrow \frac{\partial U}{\partial B_m} = -\frac{\mu}{q}. \quad (\text{straight lines !})$$

- Shielded cross-tail + corotation electric field:  $U = -\frac{a}{r} - br^\gamma \sin(\phi)$ ,  
Dipole magnetic field:  $B = \frac{B_0}{r^3}$  (equatorial plane).



## Electric Field Models

- Gussenhoven et al. (DMSF), *JGR*, 88, 5692–5708, 1983:

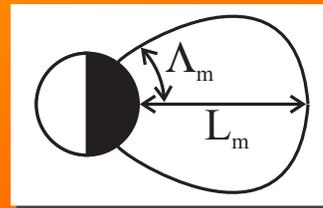
① Gussenhoven  $\Rightarrow \Lambda_m(\text{Kp})$ ,

② Dipole  $\Rightarrow L_m(\Lambda_m)$ ,

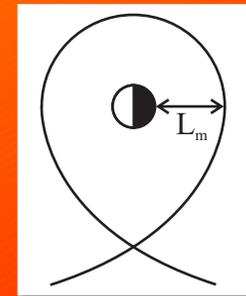
③ Electric Potential  $\Rightarrow E_c(L_m)$ .

① + ② + ③  $\Rightarrow E_c(\text{Kp})$

②



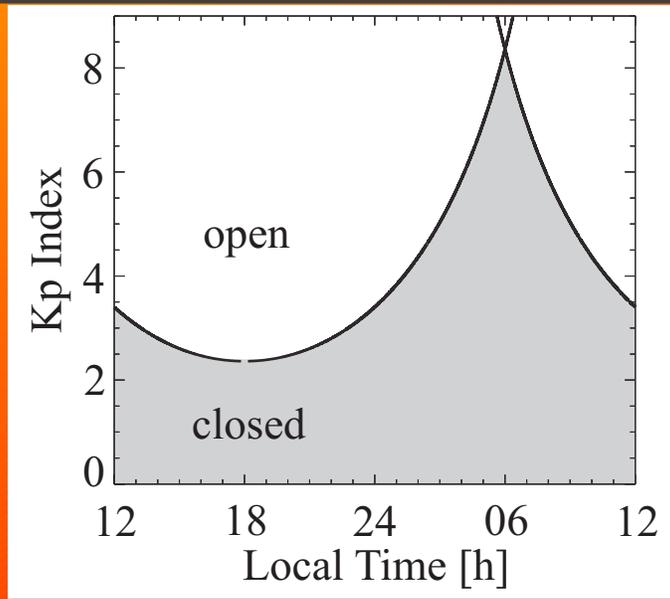
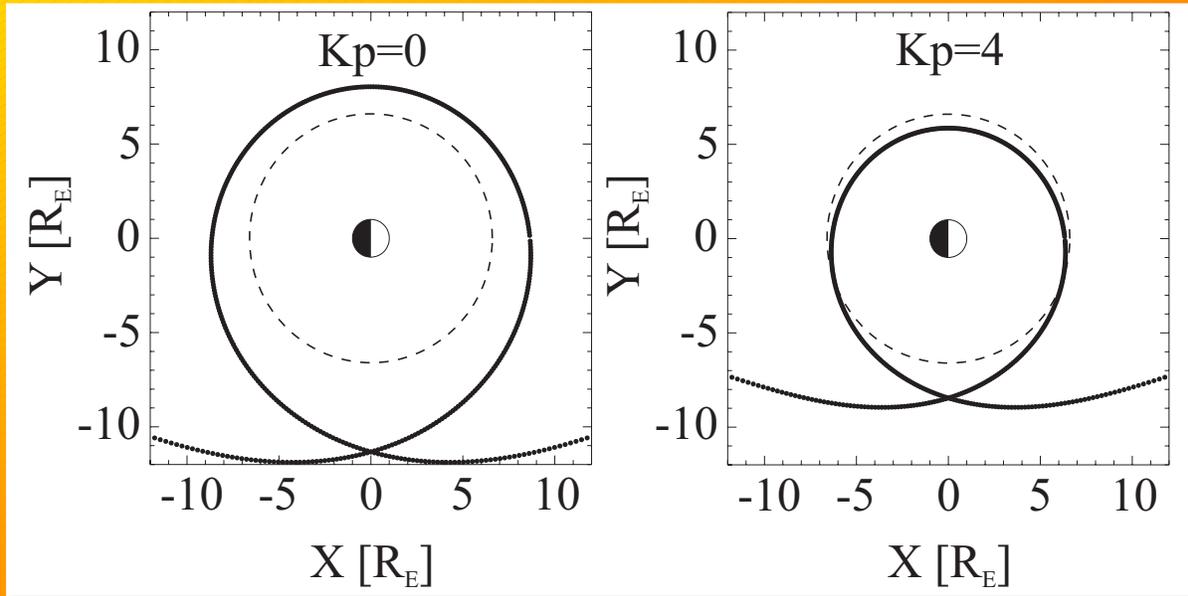
③



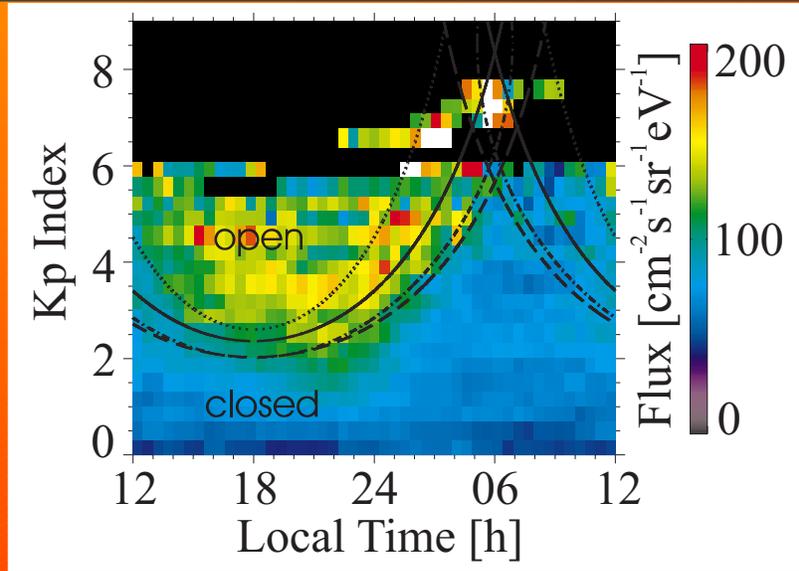
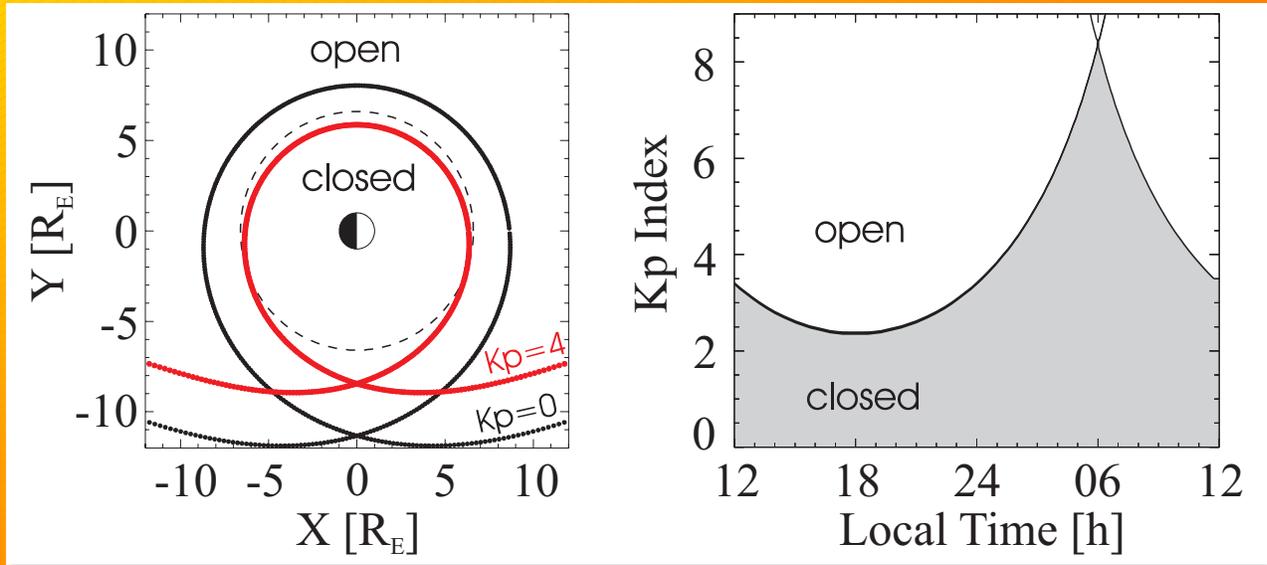
- Maynard and Chen (OGO 3+5), *JGR*, 80, 1009–1013, 1975:

$$E_c = 0.045 / (1 - 0.159 \text{ Kp} + 0.0093 \text{ Kp}^2)^3 \quad \text{for } \gamma = 2.$$

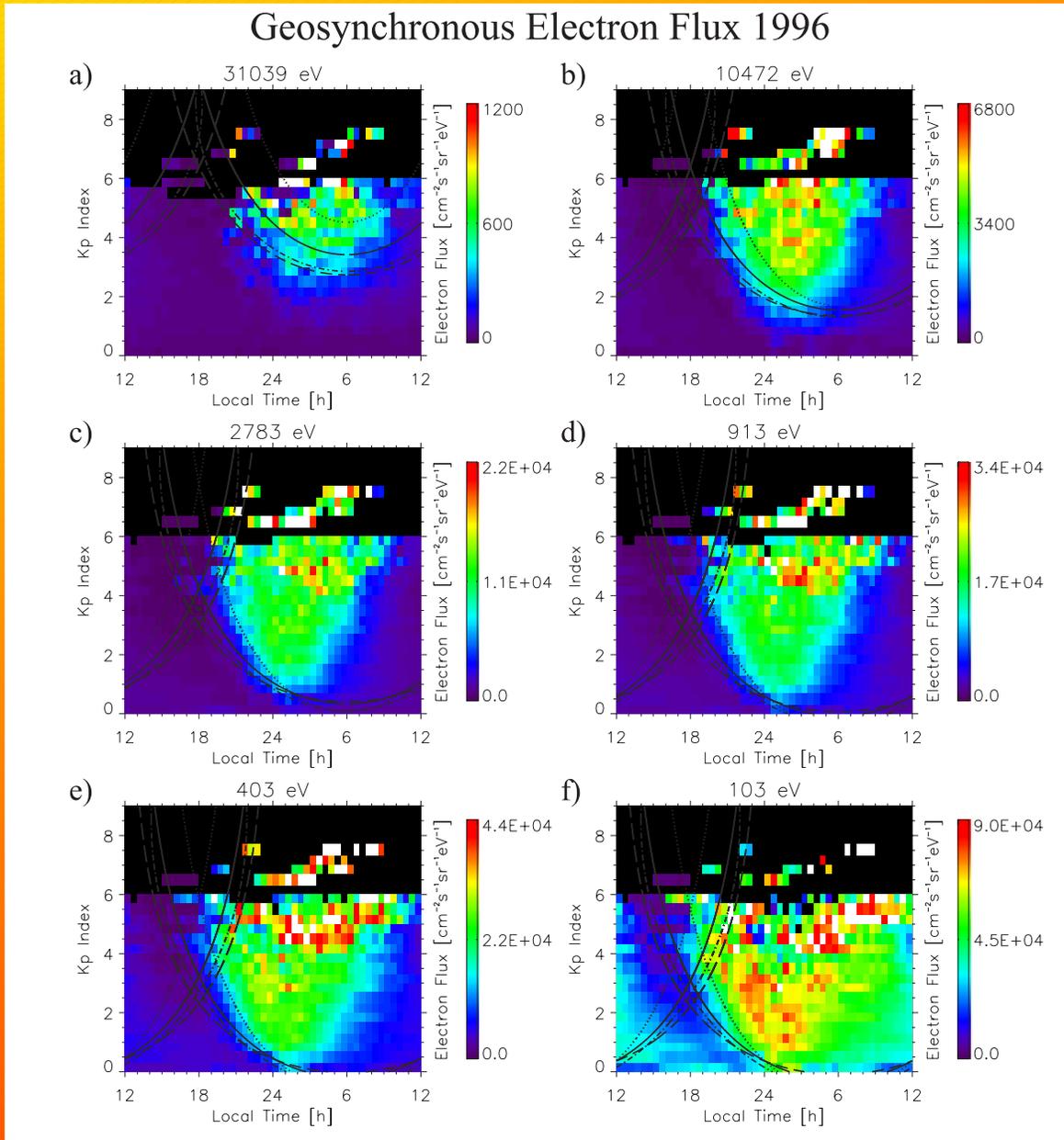
# Open/Closed Drift Separatrices for 31 keV Protons



# Drift-Trajectory Analysis for 31 keV Protons



# Geosynchronous Electron Flux 1996



## Summary of Results

- Kp provides a suitable parametrization of the electric field, but  $\gamma$  is not definitively determined.
- Evidence for distributed losses during drift.
  - Electrons  $\rightarrow$  Auroral precipitation,
  - Protons  $\rightarrow$  Charge exchange with exospheric neutrals.
- Bulk properties ( $n, T$ ) compare well with previous studies (Garrett et al., *Planet. Space Sci.*, 29, 1021–1060, 1981).

